International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 9, Issue 3, Jun 2019, 463-470

PERFORMANCE AND EMISSION CHARACTERISTICS OF A TURBOCHARGED SI ENGINE USING PETROL-ETHANOL FUEL

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ABSTRACT

With the increasing consumption of fossil fuels along with the increasing number of automobiles, there is a definite need for finding a proper replacement for fossil fuels. Also, there is a need to reduce fuel consumption today. Alternative fuels which are renewable and eco-friendly reduce the dependency on fossil fuels and also help to preserve the atmosphere by reducing the emission levels. Ethanol (10%) blended with petrol (90%) is chosen as an alternative fuel to petrol in the present study. Also, usage of energy efficiently is very important to decrease the fuel consumption. In a conventional IC engine, exhaust gasses carry heat away and this energy is wasted. To recover waste heat in order to increase the efficiency of engine by reducing the fuel consumption, turbocharger is used with the engine. The present study uses 4-stroke 3-cylinder SI engine of a Maruthi Suzuki Omni vehicle, which has with a rated power of 35 BHP. ST-9403 is used as turbocharger attached to the engine by blow through type. Mileage test is conducted for fuel efficiency and emission test is conducted to determine the emission levels produced. Petrol shows better mileage compared to E10 alternative fuel, but E10 gives lower emissions (CO emissions decreased by 20.6%). With turbocharged engine using E10 fuel, there is increase in mileage and decrease in CO emission level by 11.2%.

KEYWORDS: 4-Stroke 3-Cylinder SI Engine, ST-9403 Turbocharger, Blow through Attachment, Mileage Test & Emission Test

Received: Mar 09, 2019; **Accepted:** Apr 01, 2019; **Published:** Apr 25, 2019; **Paper Id.:** IJMPERDJUN201949

Original Article

1. INTRODUCTION

There is a large role of automobiles in the day-to-day life of mankind. The fuel consumption of these automobiles is also large in number. An approximated 14 million barrels of oil are being used per day as transportation. Thus the usage of fuel is very large in today's scenario. So, there is need to reduce fuel consumption. In a conventional IC engine exhaust gases carry a considerable heat away. To recover the waste heat, various methods are being adopted. One of them is turbo charging. Pathak Sunil[1] assessed the potentials in improving the fuel efficiency in the transportation sector by using turbo charged engine and measured the range of energy efficiency. By using turbo charged engines in light weight vehicles, the volumetric efficiency and power output increases. Mohd Muqeem et al[2,] by using different techniques in turbocharging, engine output increases and emission levels decreases. Engine downsizing is possible with turbocharged engines for higher outputs. Waadysaaw Mitianiec et al[3] described algorithm to control the charge distribution in turbocharged engine to avoid knocking problem at different speed levels. Abhishek Saini[4] designed single cylinder turbocharged SI engine to

increase engine efficiency and volumetric efficiency by inducing maximum charge. Prashant S. Jadhav[5] et al used turbocharger running by exhaust gases for 100CC engine and observed the improvement in efficiency. Mohammad Israr[7] et al, experimented on single cylinder SI engine turbocharging by coupling to an air-water inter cooling system to decrease the inlet air temperature and observed the increase in power output and reduction in emissions. From the results, they concluded that the power as well as the efficiency is increased by 10 to 15 % and emissions decreased. Norbert Zsiga[8] et al, studied on a turbo charged SI engine to know the effect of intake manifold boosting by varying load and engine speed. Boosting of intake manifold with turbocharger can be used for downsizing of the engine. Michael R. Buchman et al[9] done experimentation on single cylinder, four stroke engine using turbocharging and concluded that air capacitor is needed to maintain turbo pressure at the time of intake for four stroke engine. A. Elfasakhany[10] investigated the effect of ethanol-petrol blends in different proportions on the performance of a spark ignition engine and noticed that the engine power is improved with addition of ethanol and the maximum improvement occurred when E10 blend is used and the emissions also reduced. Mohamed A. Ibrahim [12] investigated on four stroke four cylinder SI engine using gasoline- ethanol blends in different proportions at different speeds and compared results with the same engine running with petrol. They concluded that ethanol blends enhances the performance and reduces the emissions.

2. EXPERIMENTAL PROCEDURE

A Maruti Suzuki Omni 5STR engine with carbureted fuel supply system vehicle is used for the analysis. Turbocharger is mounted in between the engine exhaust manifold and muffler and is kept near the exhaust manifold to reduce heat losses and improve the efficiency. Mileage test and emission test are conducted on the engine to study the performance and emission characteristics. Petrol and E10 are used as fuels and the experimentation is carried out with and without turbocharger. Initially, mileage test is conducted for standard petrol fuel. Then, E10 fuel (Petrol-90% + Ethanol-10%) is used for conducting the mileage test on the vehicle. Ethanol blend is used as an alternative fuel source for SI engine.

Table 1: Specifications of the Engine

Engine	Maruti Omni
Displacement	796 CC
No. of Cylinder	3
Max. Power	35 BHP @5000rpm
Max. Torque	59.84 Nm @3000rpm
Bore	68.5 mm
Stroke	72.0 mm

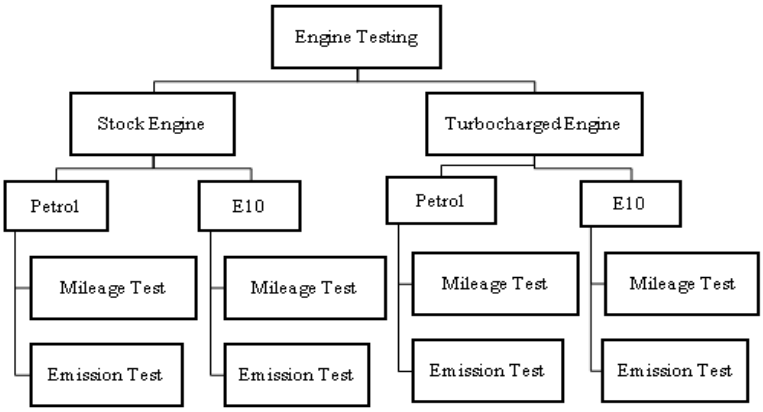

Figure 1: Line Diagram Showing Experimentation Conducted

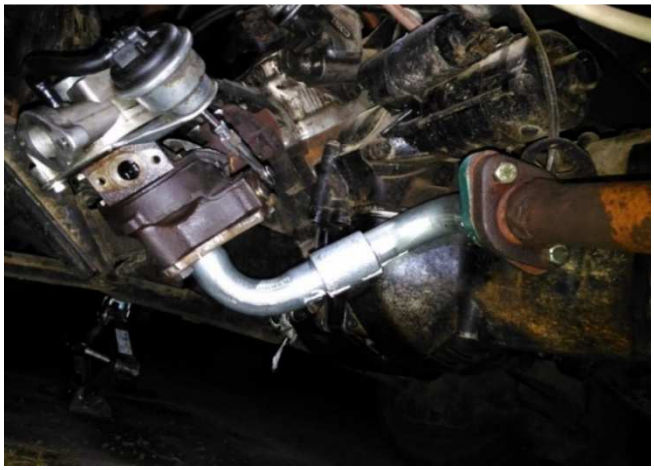

Figure 2: Turbocharger Attachment to the Vehicle

2.1. Mileage Testing

Mileage refers to the fuel consumption. Higher mileage indicates lower fuel consumption, which in turn indicates better performance of the fuel. It is the total distance travelled by automobile for a specified quantity of fuel. Here, in the present study mileage is measured in kilometers per liter (kmpl).

2.1.1. Mileage Test Procedure

- Measure 1liter of fuel using measuring jar.
- Engine is made to run with 1 liter of fuel at a constant speed of 40kmph to obtain economy.
- The distance travelled by the vehicle is noted down.
- Three such trails are conducted to obtain accurate results.

Figure 3: Mileage Testing Equipment

2.2. Emission Testing

Due to the combustion of fuels in the vehicle, exhaust gases are produced such as hydrocarbons, carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxide etc. This is called emission of gases in an automobile. In the emission test, the exhaust gases are measured with the help of a five gas analyzer.

2.2.1 Emission Test Procedure

- Run the vehicle with the fuel approximately 5 kms.
- Insert the probe into the tailpipe of the engine which is a direct sensor measurement through filter arrangement.
- Readings are displayed on the screen and saved.
- Note down the readings.

Figure 4: Exhaust Gas Analyzer

3. RESULTS AND DISCUSSIONS

3.1. Mileage Results

Mileage testing is done by running the vehicle with and without turbocharger using petrol and petrol-ethanol blend in 10% by volume and the values are noted for three runs. The Mileage of the vehicle is decreased initially due to the turbo lag. Later, the mileage is increased. In the trail run 1, the mileage decreased by 10.77%, then in trial run 2 and 3the mileage increased to 29.70% and 27.51% with respect to the initial condition of the vehicle. Mileage of the vehicle with turbocharged engine run with petrol increased significantly by 42% in three trails compared to that of the engine without turbocharger. Mileage of the vehicle with turbocharged engine run with E10 blend increased by 13.4% in three trails compared to that of the stock engine.

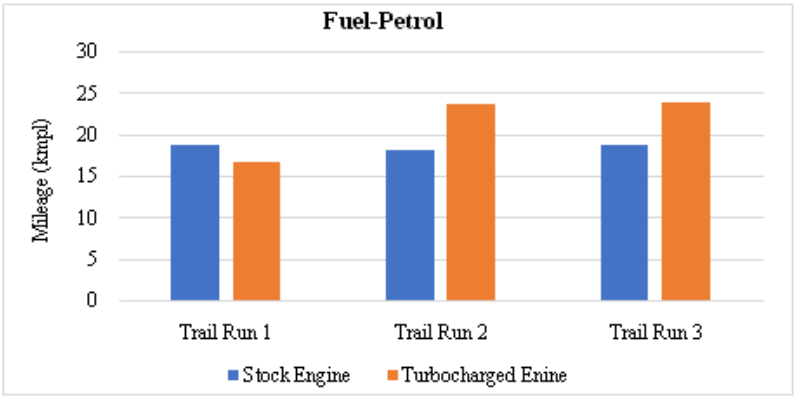

Figure 5: Comparison of Engine Mileage with and without Turbo Charger using Petrol

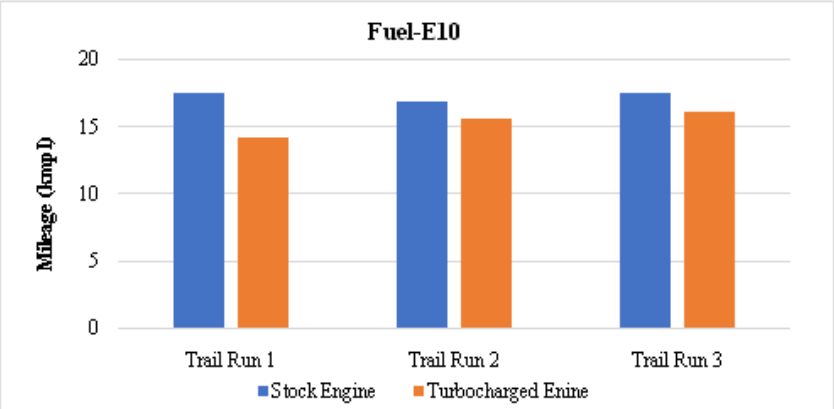

Figure 6: Comparison of Engine Mileage with and without Turbo Charger using Petrol-Ethanol Blend

3.2. Emission Results

Engine emissions CO, $CO_2$and HC are measured using gas analyzer while running the vehicle with and without turbocharger using petrol and petrol-ethanol blend with 10% by volume. In turbo charged engine running with E10 blend emissions CO, $CO_2$and HC reduced by 11.2%, 6.9% and 19%, respectively compared with petrol.

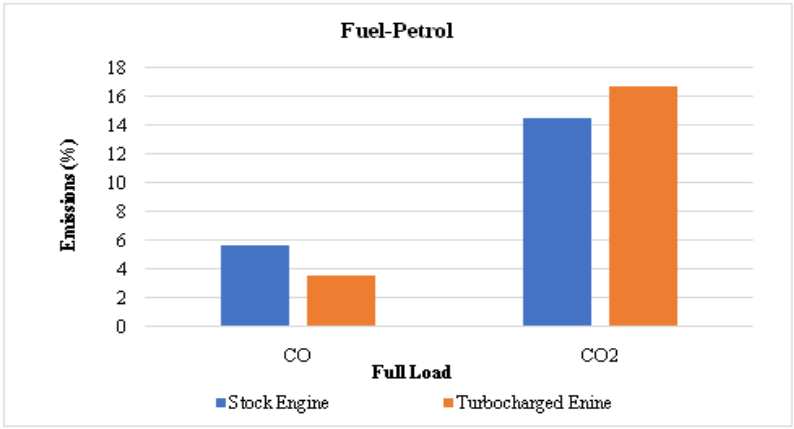

Figure 7: Emissions of CO, CO2 from Engine with and without Turbocharger using Petrol

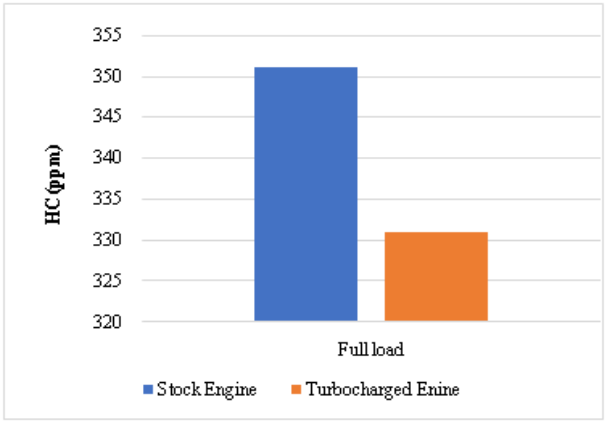

Figure 8: Emissions of HC from Engine with and without Turbocharger using Petrol

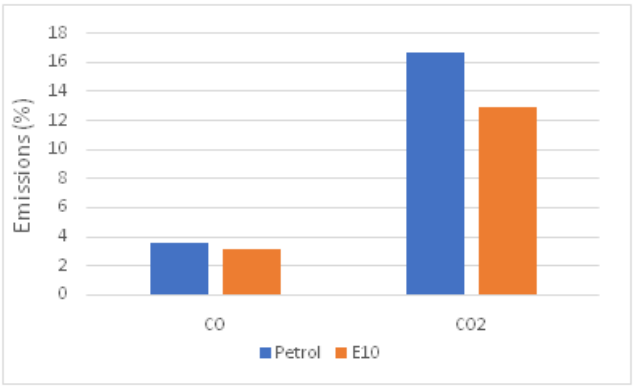

Figure 9: Emissions of CO, CO2 with Turbocharged in Using Petrol-E10

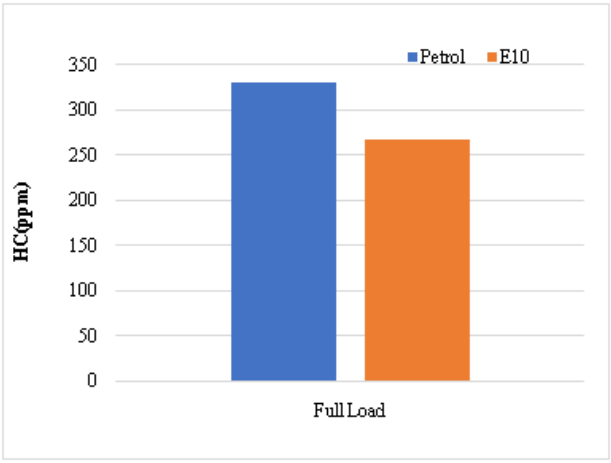

Figure 10: Emissions HC in Turbocharged Engine with Petrol & E10

4. CONCLUSIONS

The following conclusions are drawn from the experimental results obtained:

- Turbo charging decreases the fuel consumption of the vehicle and leads less emissions
- Petrol gives better mileage when compared to E10 blend.
- E10 blend gives fewer emissions compared to petrol.

Thus, it can be concluded that turbocharger can be attached to SI engine in order to reduce fuel consumption as well as emission levels. Though E10 shows lower level of emissions, it is not suggested to use in SI engine due to its very low fuel efficiency.

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